

Development of High Density Cluster-Jet-Targets for Storage Ring Experiments

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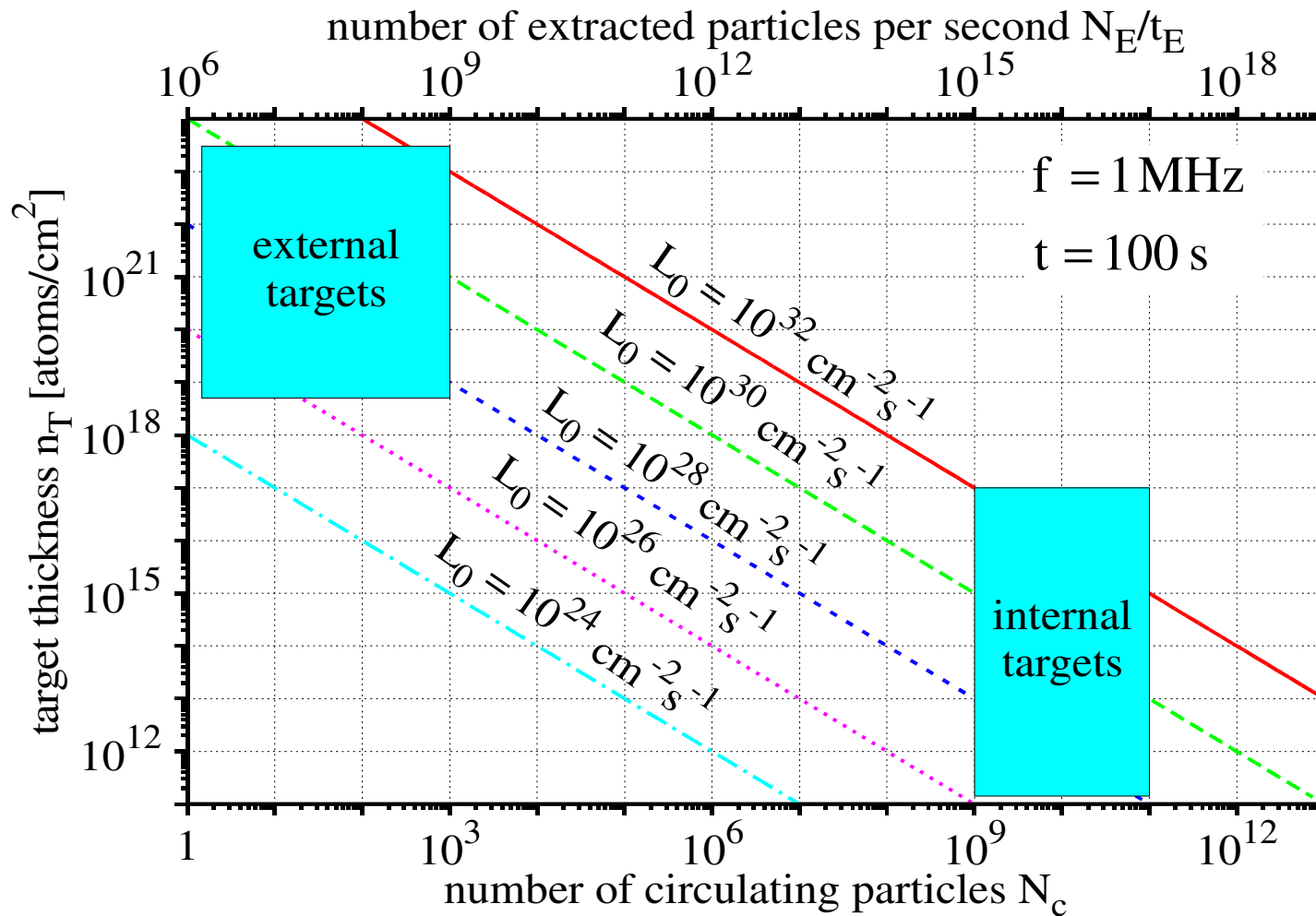
Bundesministerium
für Bildung
und Forschung

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Peak luminosity of internal and external targets



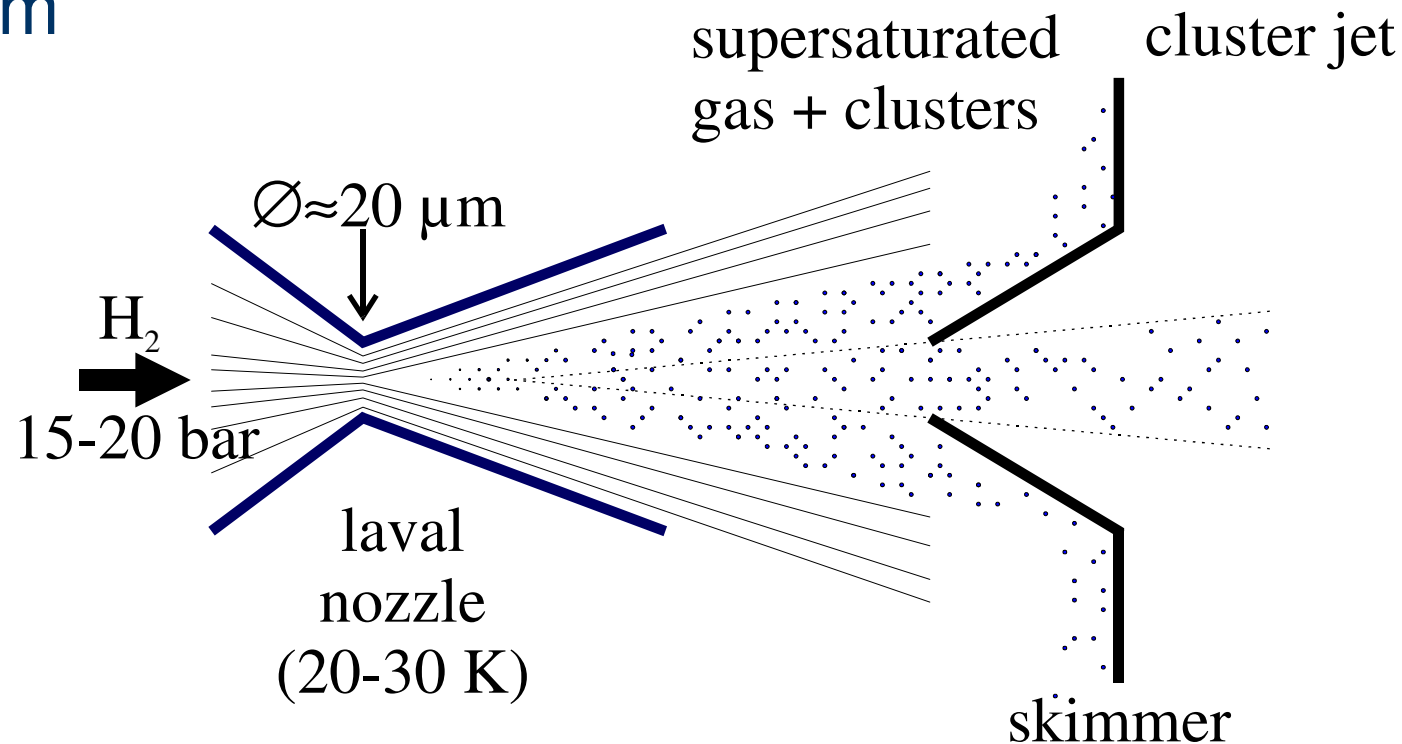
⇒ lower target thickness = no secondary reactions
+ better momentum resolution

Requirements for internal targets

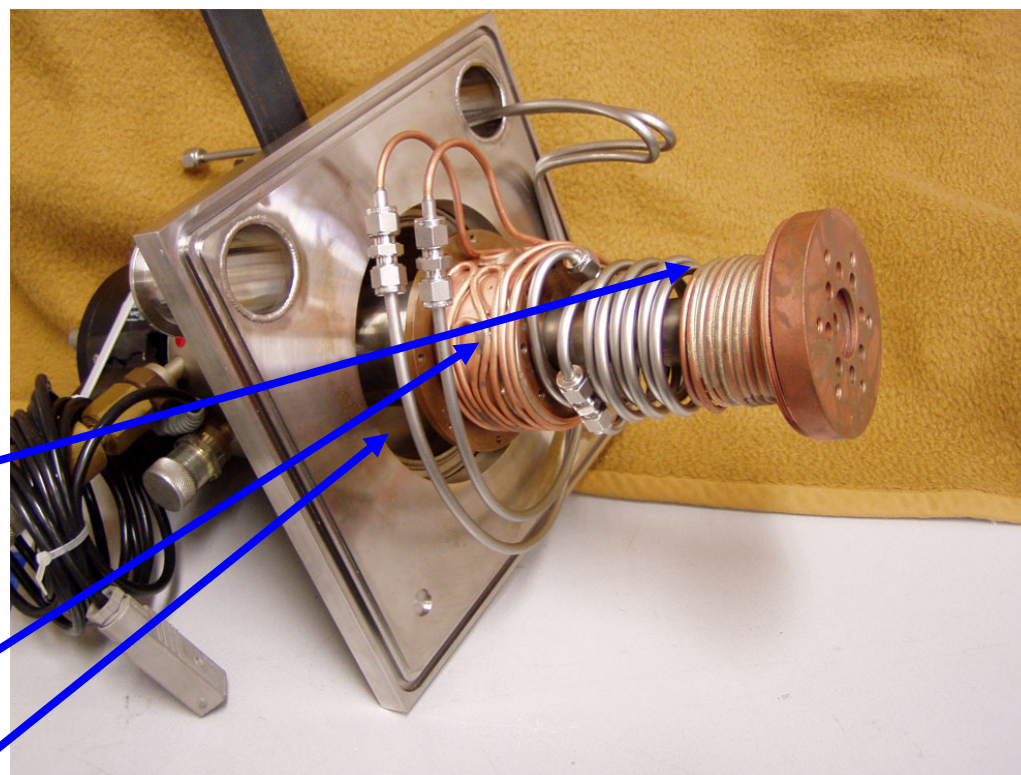
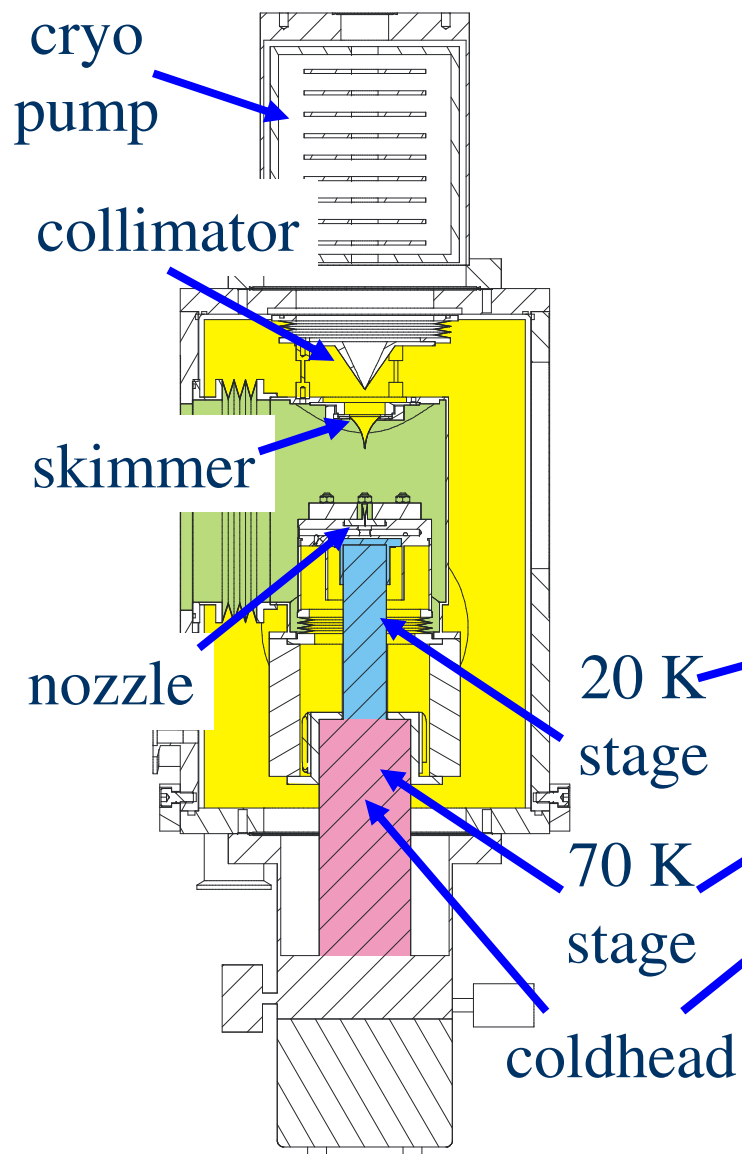
- target thickness should be
 - constant in time
 - stable (constant) spatial distribution
 - adjustable over several orders of magnitude
- high purity of target material (especially no windows)
- low influence on vacuum conditions in the accelerator
- target size and shape customisable
- possibility to switch the target on/off at any time

Cluster Jet Targets

- principle of operation:
purified H_2 or D_2 gas at high pressure and low temperature passes a very thin laval nozzle
 $\Rightarrow$ formation of a cluster-jet surrounded by a gas beam



The Münster cluster-jet source



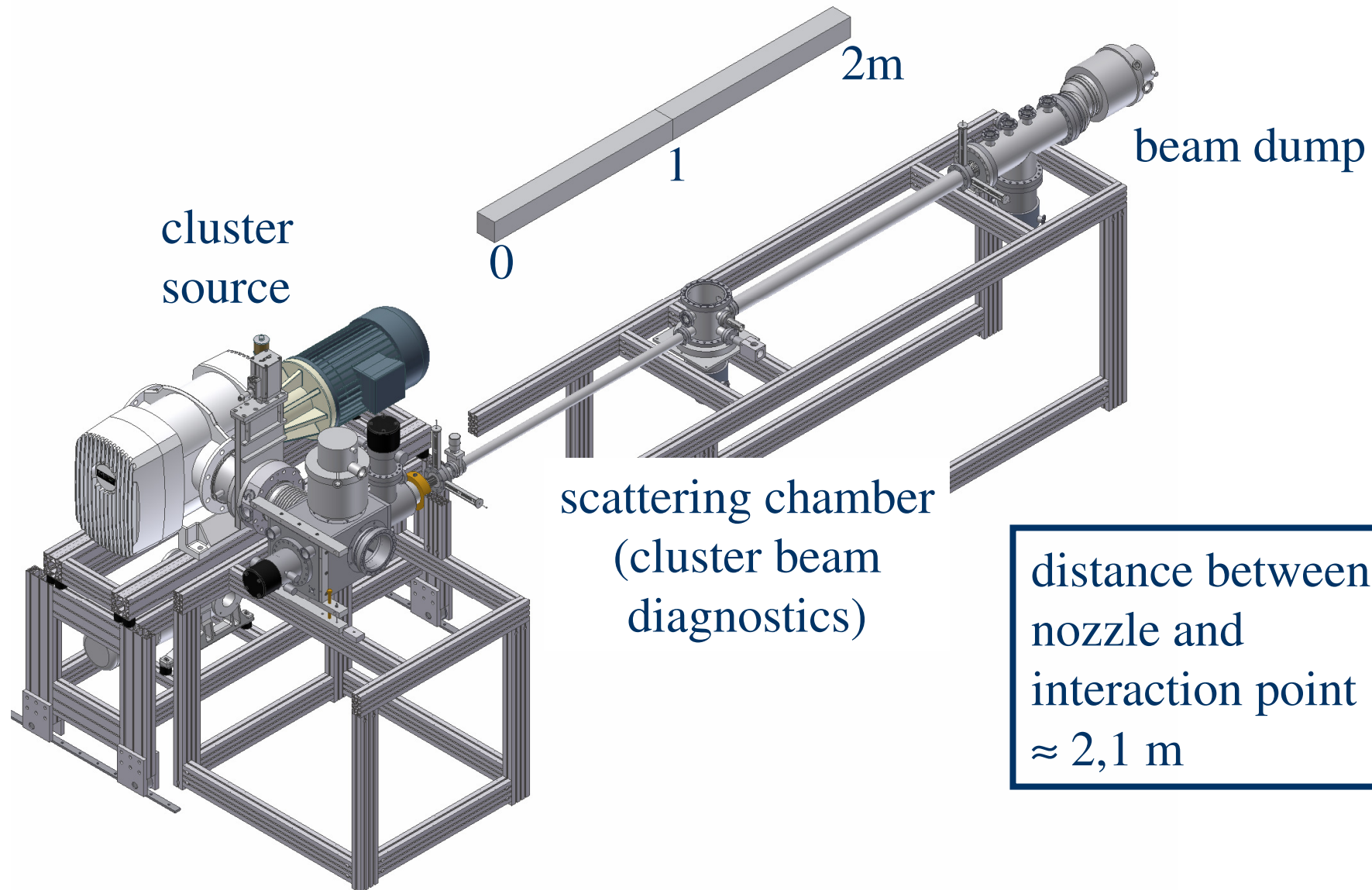
Performance of established Hydrogen Cluster Jet Targets

	CELSIUS	E835 Fermilab	ANKE COSY11
Nozzle diameter	100 μm	37 μm	11-16 μm
Gas temperature	20 – 32 K	20 – 32 K	22 – 35K
Gas pressure	1,4 bar	< 10 bar	14 – 20 bar
distance from nozzle	0,32 m	0,26 m	0,65 m
Target thickness	$1,3 \times 10^{14} \text{ cm}^{-2}$	$3 \times 10^{14} \text{ cm}^{-2}$	$\geq 10^{14} \text{ cm}^{-2}$

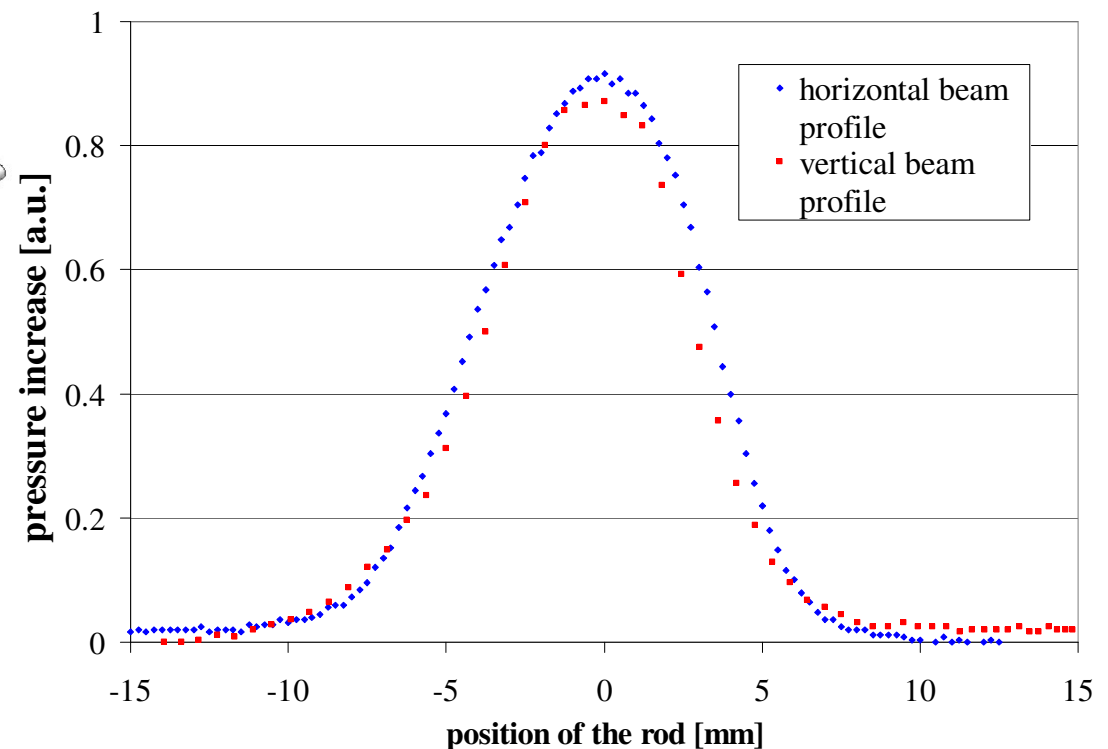
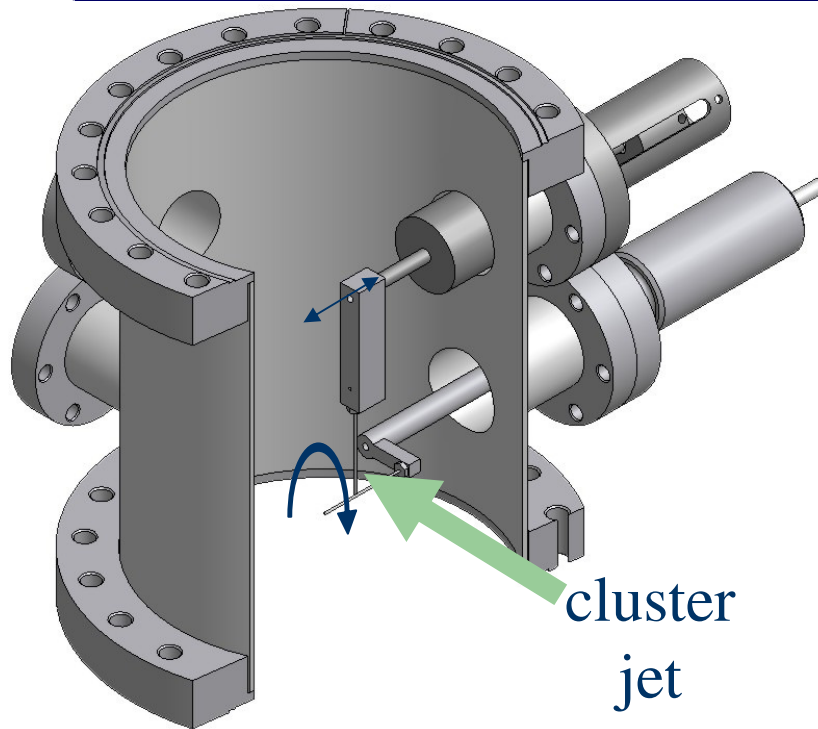
Next generation experiments in hadron physics will have a **distance d** of **2 m** between nozzle and interaction point

$n_T \propto d^{-2} \Rightarrow$ **target thickness** must be improved by 1-2 orders of magnitude

The cluster target setup in Münster



Measurement of the target thickness



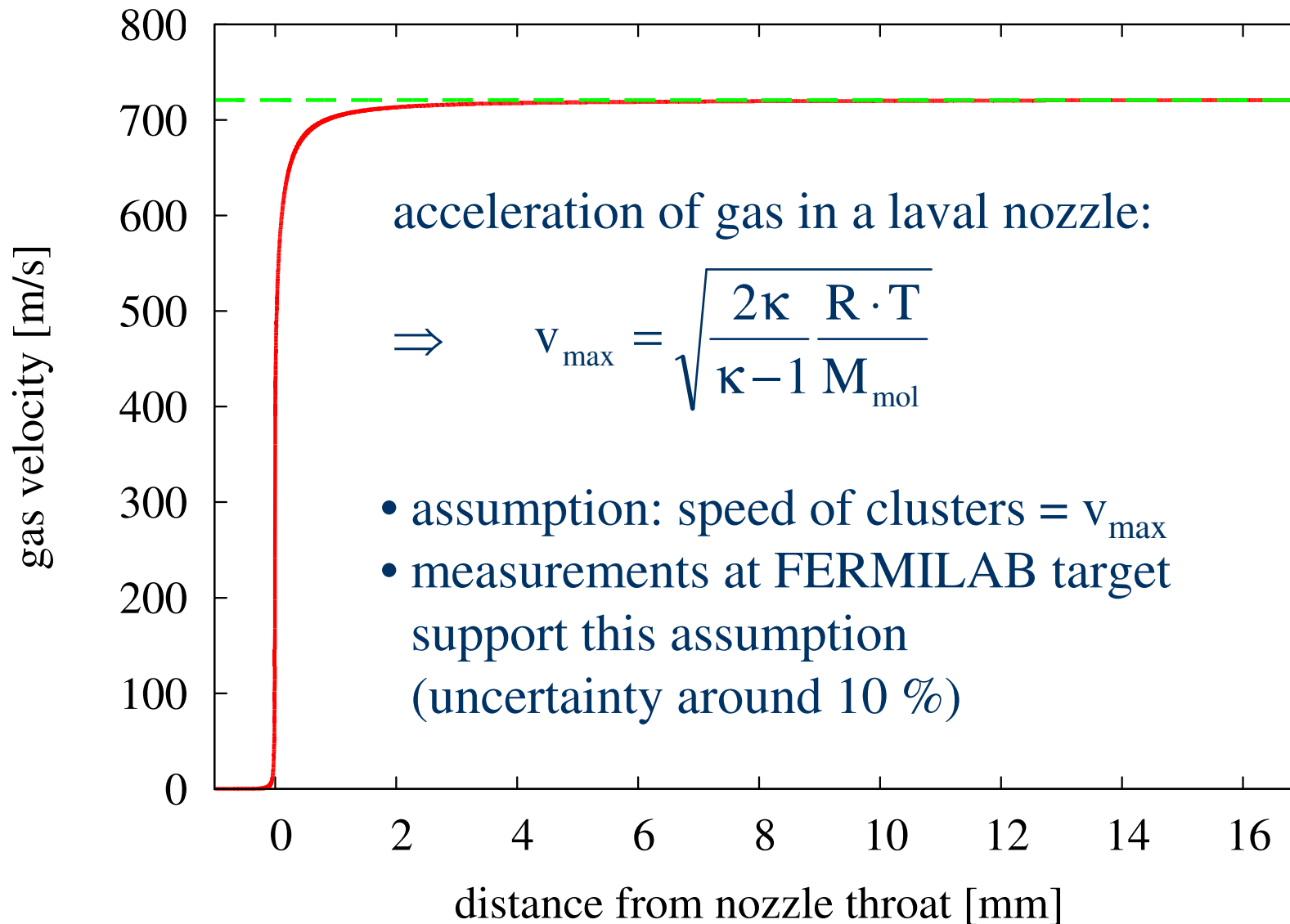
$$n_T = \frac{\Phi_{\text{jet}}}{A \cdot v_{\text{jet}}}$$

Φ_{jet} = cluster jet flow (atoms/s)

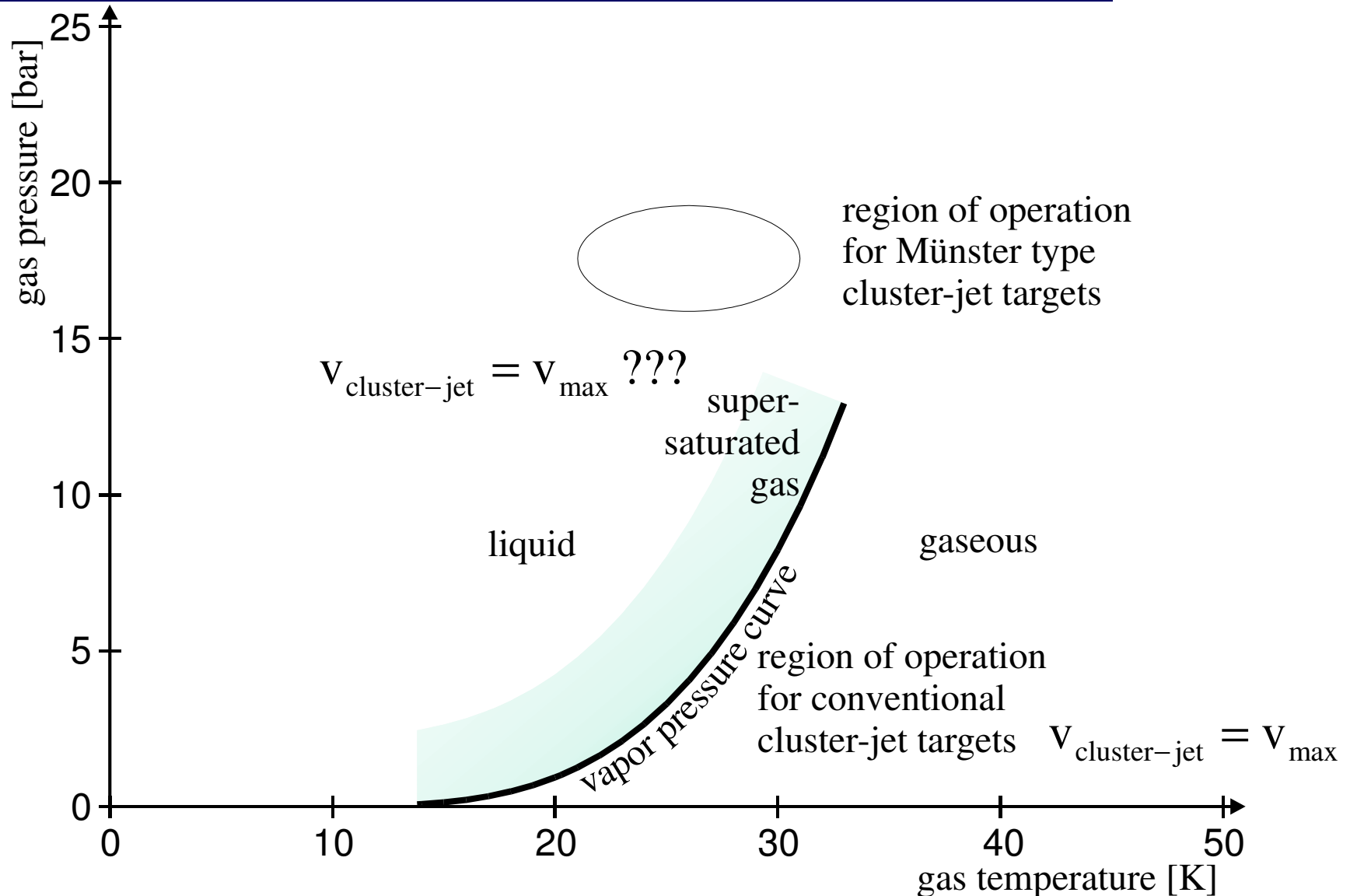
A = cluster jet cross section

v_{jet} = cluster jet velocity

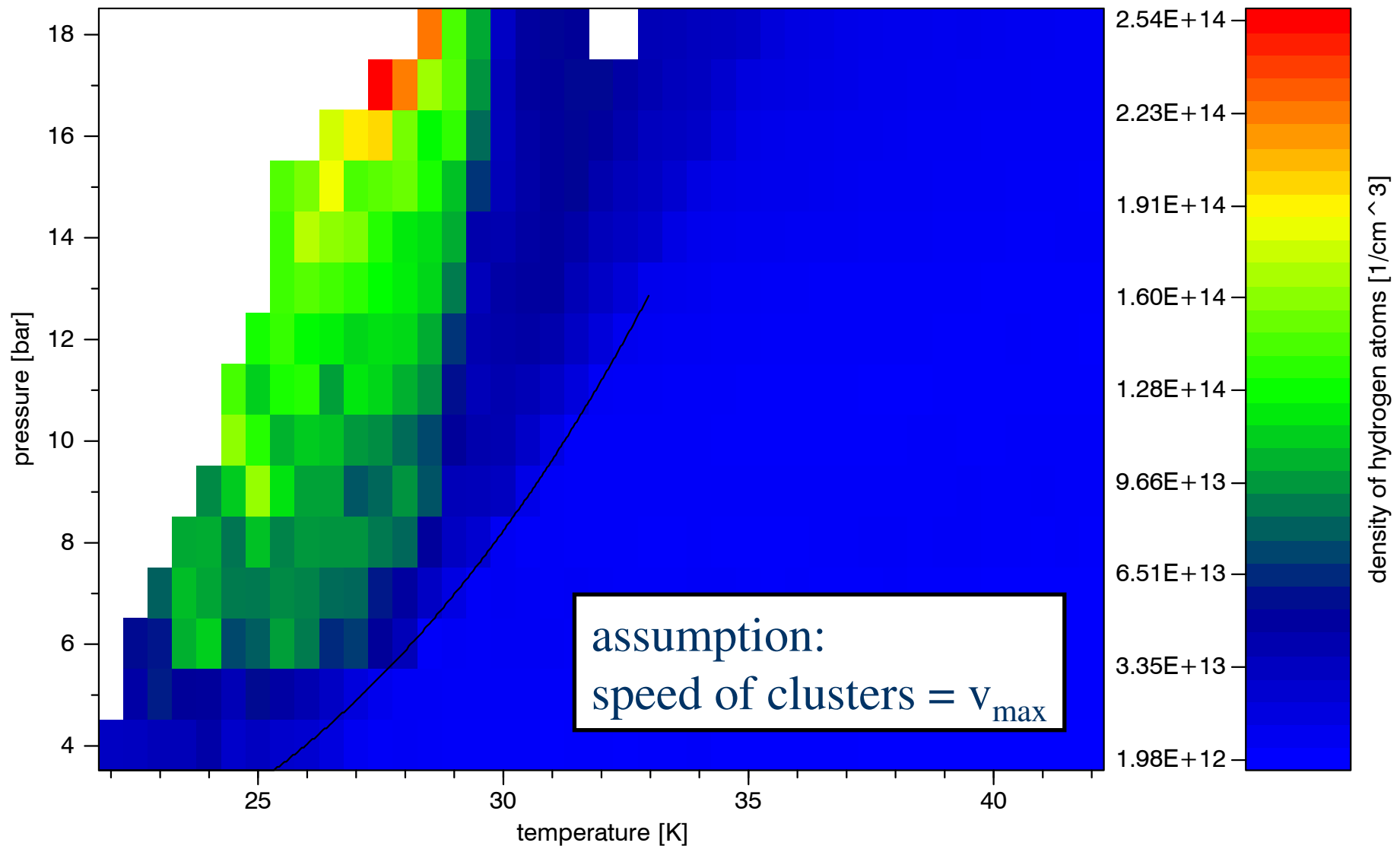
Theoretical determination of the cluster-jet velocity



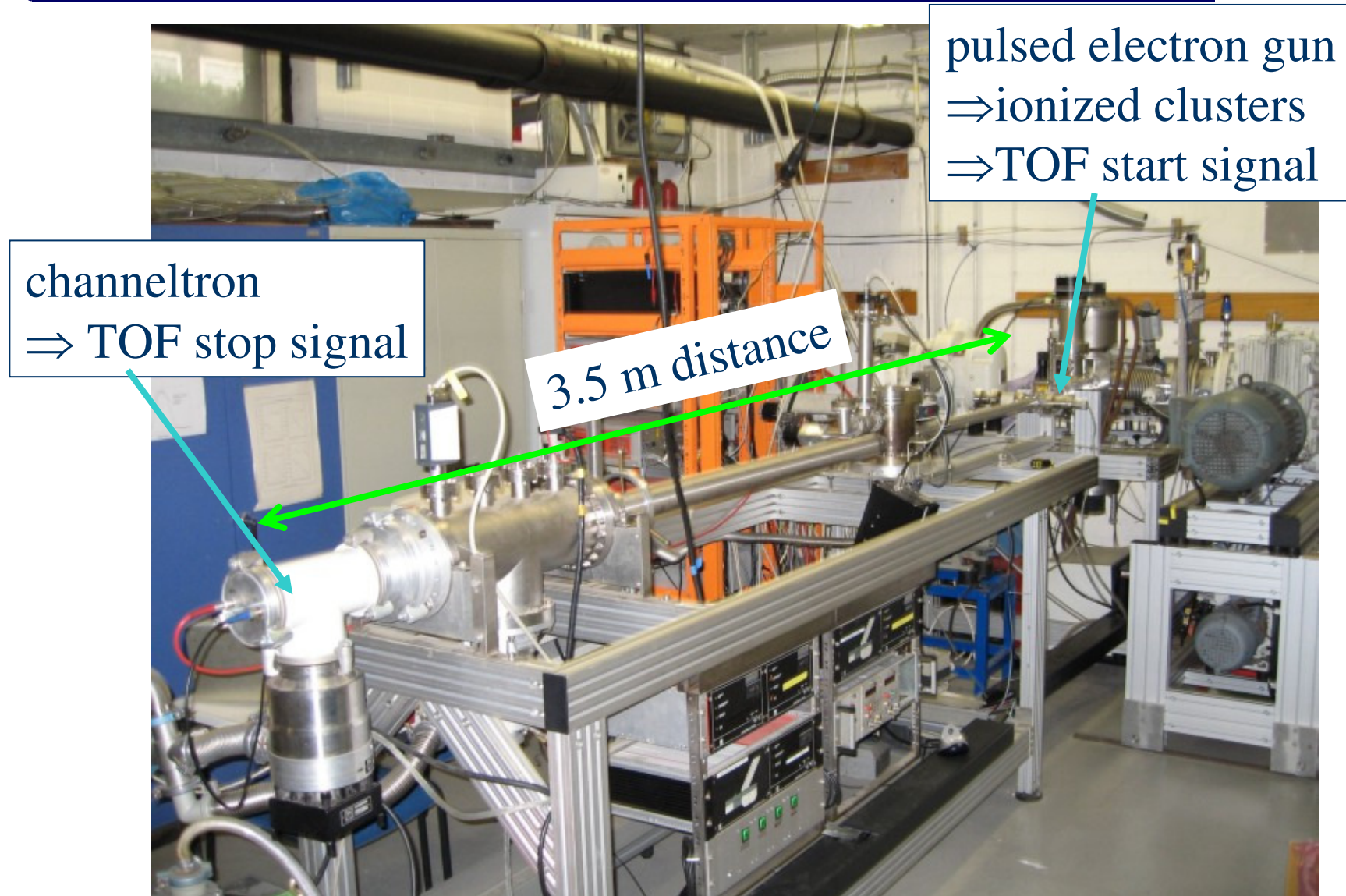
Region of operations for different types of cluster-jet targets



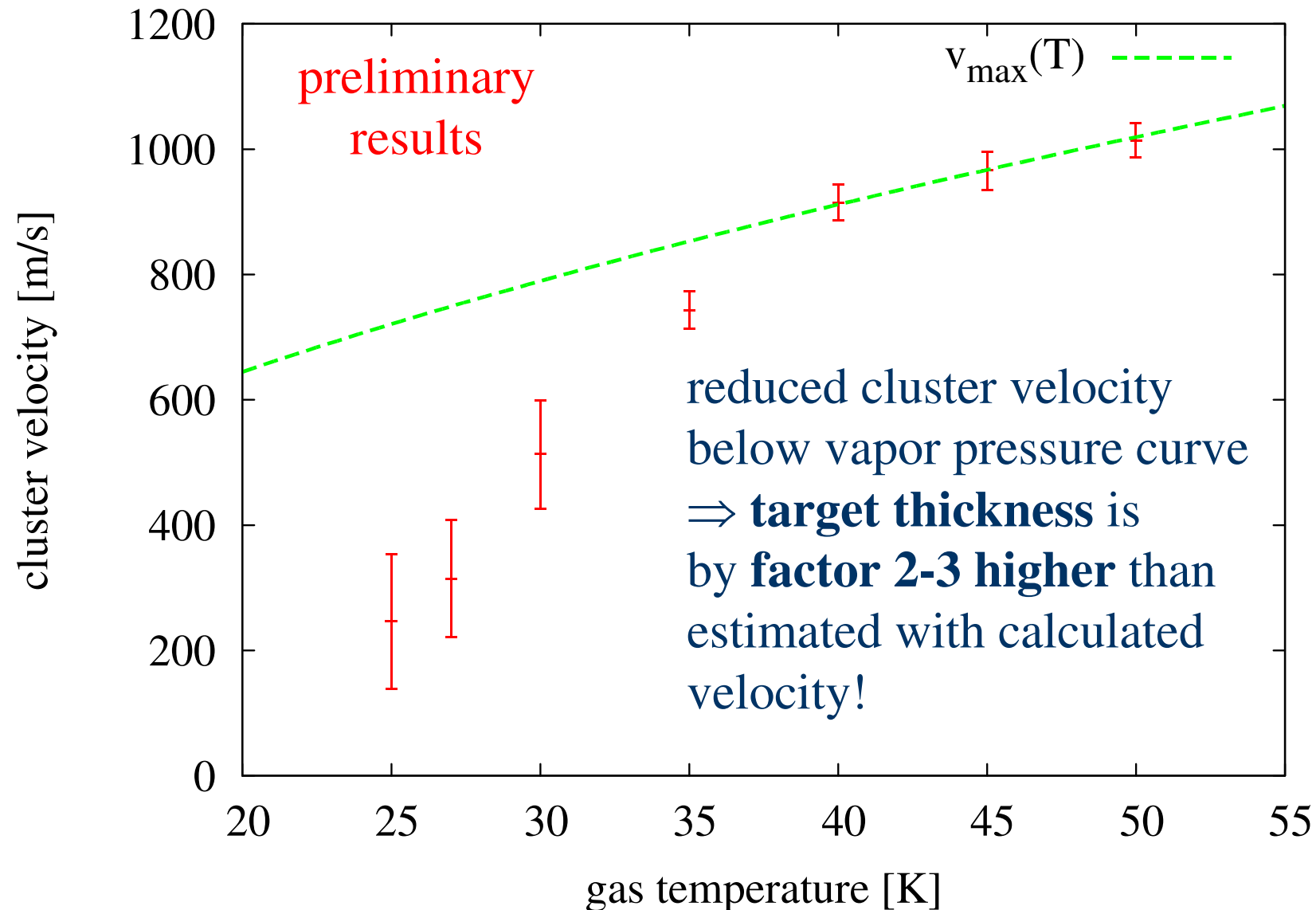
Density map of the cluster jet target in Münster



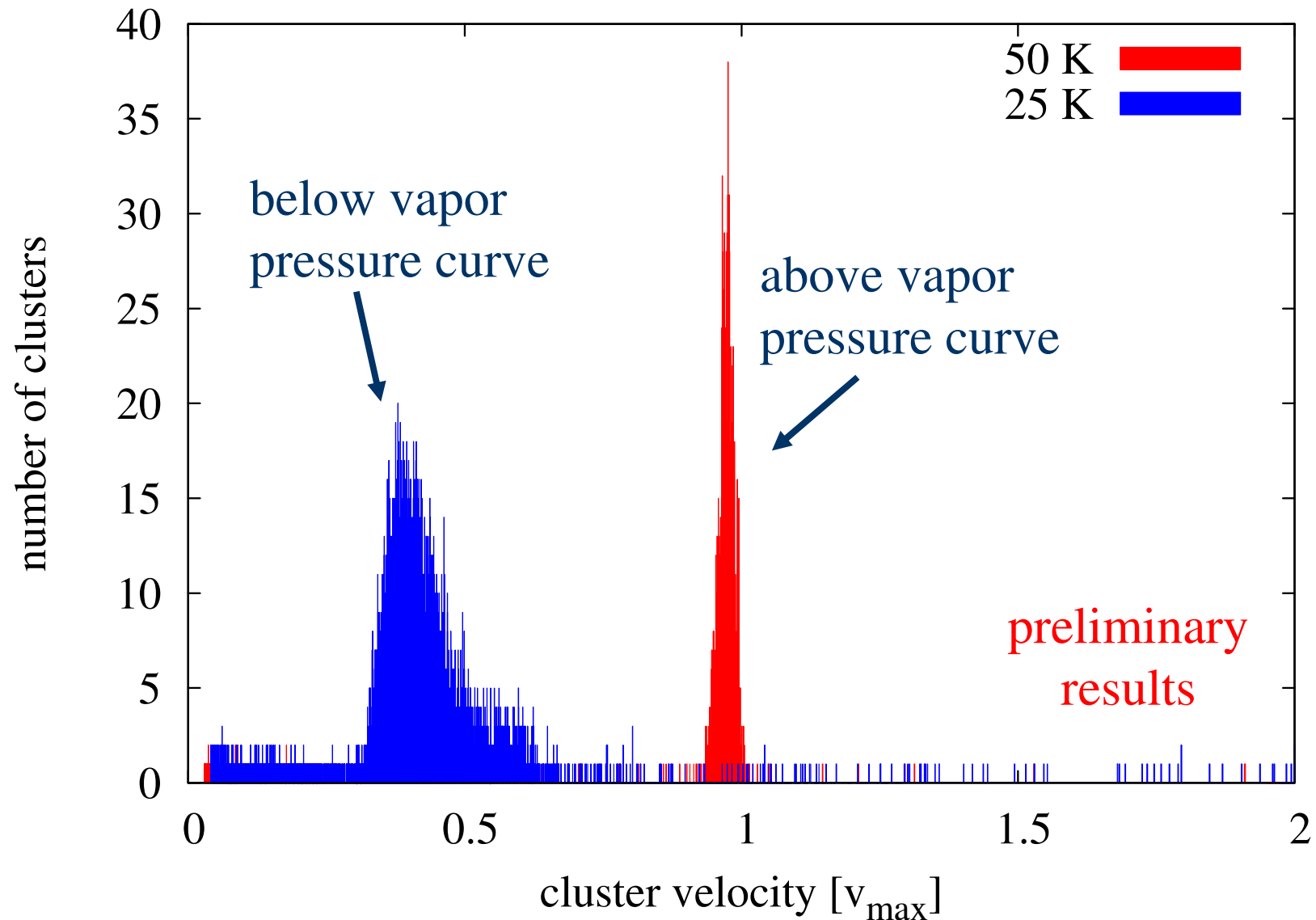
Time of flight measurement of the cluster-jet velocity



First results: cluster jet velocity



Distribution of cluster velocities



Achievements

	CELSIUS	E835 Fermilab	ANKE COSY11	Münster
Nozzle diameter	100 μm	37 μm	11-16 μm	16-28 μm
Gas temperature	20 – 32 K	20 – 32 K	22 – 35K	20 – 35K
Gas pressure	1,4 bar	< 10 bar	14 – 20 bar	> 18 bar
distance from nozzle	0,32 m	0,26 m	0,65 m	<u>2,1 m !!!</u>
Target thickness	$1,3 \times 10^{14} \text{ cm}^{-2}$	$3 \times 10^{14} \text{ cm}^{-2}$	$\gg 10^{14} \text{ cm}^{-2}$	$> 4 \times 10^{14} \text{ cm}^{-2}$

Design of a new cluster target source as prototype for the PANDA experiment

